Su-15

Content

Short note

Su-15 – semiautomatic 2Mach interceptor with missile armament, typical fighter of second generation. I made model of it as part of personal private investigation of Yury Gagarin death and Soviet "Big Space" project folding mostly. Since official plane documentation is not presented at common domain yet, model can differ from original, but it keeps its specialties, and represents it well; particularly, says that some hooliganism on it is quite doubtful, while order execution is quite probable.

Plane, which is very effective at its main tasks solving, has comparatively low characteristics at low speeds and altitudes – it is not very stable, needs high attack angles for horizontal flight, etc. To 1968 it flew three years already, each pilot of that plane knew these features for sure.

All-weather radar of machine could be used as artificial horizon stunt, and with great probability would be turned on with lowering below clouds level, at 450m altitude – about which, believing to friend of Gagarin, and first human made the EVA, Alexey Leonov, witnesses says. Then, going to echelon again, pilot would see mark of MiG-15UTI of Gagarin and Seregin at radar; with target altitude excess of 2..3km – by 10..15 distance. At subsonic it is more that one minute.

Test pilot, who flew Su from Chkalovsky, central test airfield of country, for sure knew about effect of tailwind turbulence. Random interception at automatic mode is excluded – real automate turned machine away from target at close distance to avoid collision, as automate of model does.

In combination with external tanks, which was left at Gagarins plane prior simple, still aerobatics, exam mission, and wrong clouds lower border information, that he got from meteorological service, it looks much more as intentional diversion.

Last but not least, plane was part of semiautomatic interception system, it worked at missions in pair with ground radar, sending exact procedural data to it via binary radio channel. That ground radar was not obligatory for some test mission, but if that was presented there then its crew saw each maneuver of both planes.

It would be possible to believe in some occasional amateur performance on some other aircraft, but with Su-15 it is doubtful both technically and psychologically. Each machine has its character. Character of that one is heavy. It not provokes any amateurism.

Who would need to retire first cosmonaut of planet, and for what reason? Partially, answer on these questions is provided by internal structure of FlightGear simulator, at which "Su-15" model flies. Community, that declaring quite similar to communism Open Source principles, at fact went out to be one exploiting enthusiasm intentionally – competitive instead of mutual, made by "divide and rule" principle as some Tom Sawyers fence, controlled by sole man owning all infrastructure, who made steps as hidden censorship even to keep anything in cotrol.

At society really having space mastering as some priority – not one would remove Gagarin. At society declaring such mastering in political purposes – order to make it could went from tops of management.
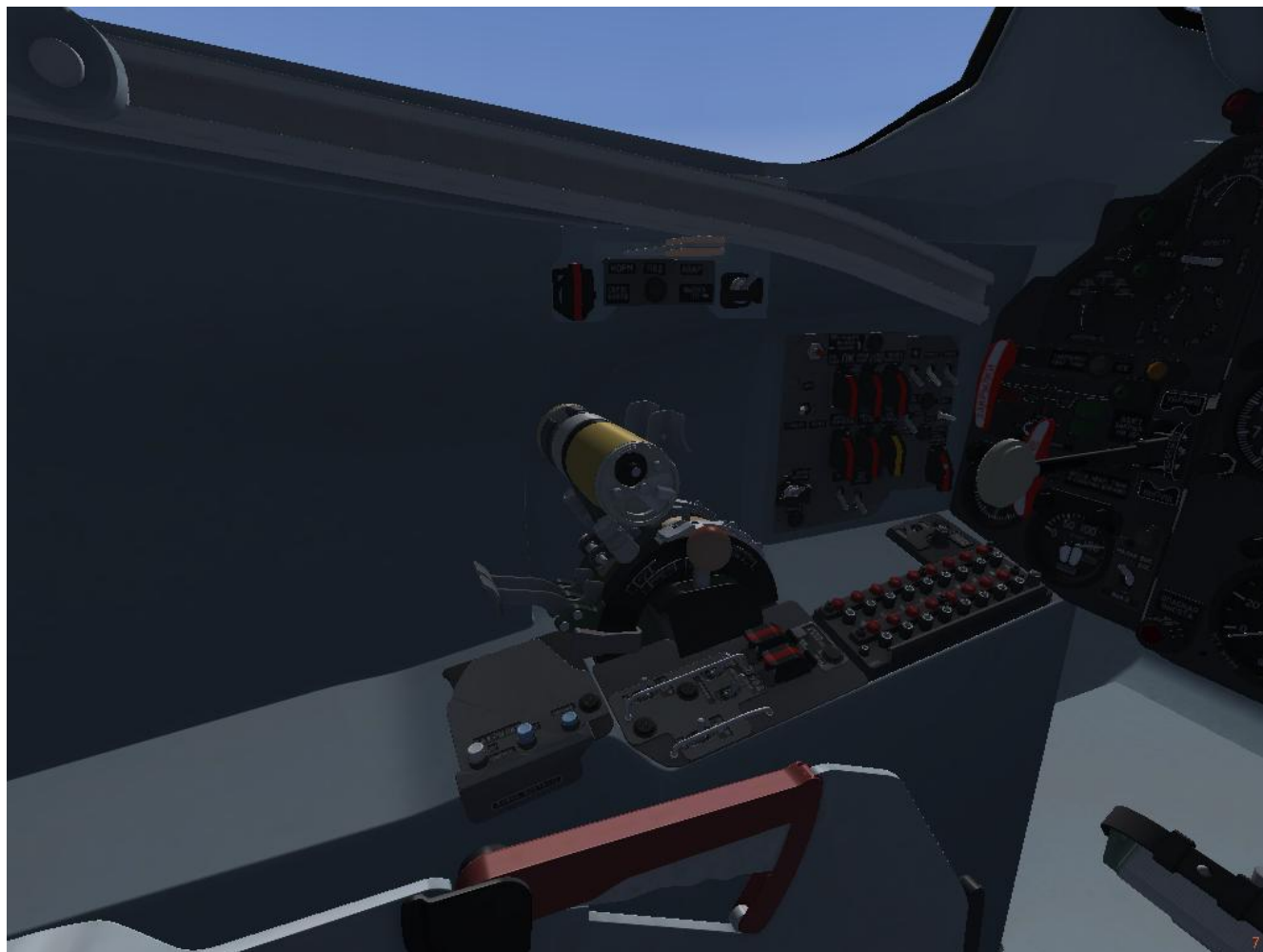
With best regards, Slavutinsky Victor, social psychologist
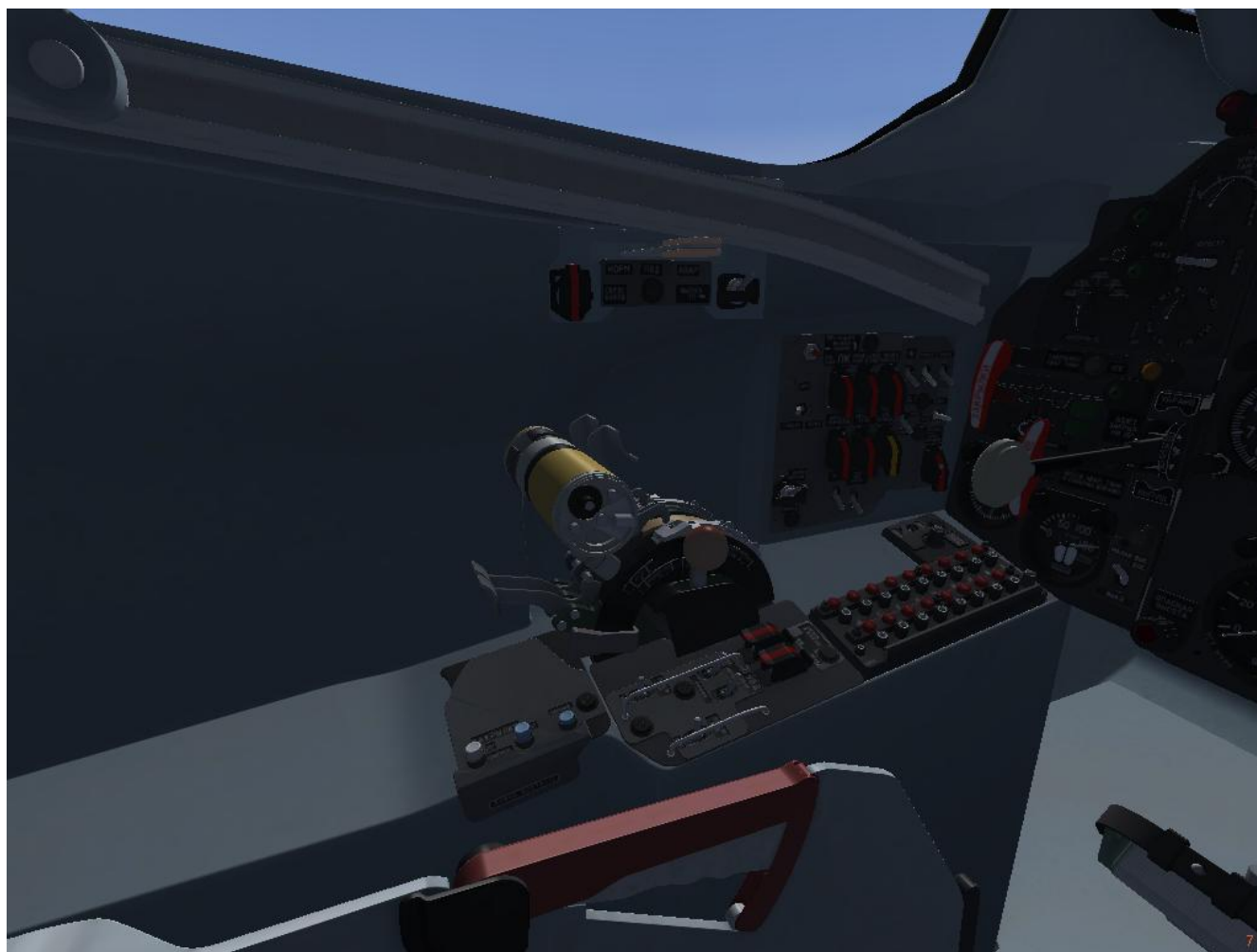
Starting sequence

Switch to left panel view by consistent **v** key pressing.

Lift up throttle handles by keeping **PgUp** pressed.

Switch low throttle protectors on by **Shift-r**, lower throttle handles at protectors by keeping **PgDown** pressed.

Switch to right panel view by **v** key pressing. Turn on two accumulators by left mouse button pressing at small commutation panel; then pumps, control instrumentation, ignition arc, starter-generators, lights at big one. If left mouse button not changes switches positions then switch to correct mouse mode by **Tab** button pressing. Also, that electrical scheme could be turned on by **Shift-e** keys

Switch to main panel view by consistent **Shift-v** pressing. In case warning lamp is ignited and warning bell sounds, switch these off by **w**. Keep **s** key pressed until engines went to idle throttle— 60% of second stage spin, 30% of first. Changing to idle mode is accompanied by engines sound changing.

Switch to right panel view, and turn on all generators at small commutation panel.

Turn on all switches at big commutation panel by common red switch. Also, that mode can be switched on by **Ctrl-e** keys.

Close canopy by **Shift-c** keys pressing.

Course system

Plane is equipped with course system, which can control major flight operations — takeoff, following to the beacon, convoying, interception, and landing — fully automatically, or at so called directional mode, at which automate, by additional needles at course, altitude and speed indicators, advising need flight parameters to pilot.

Panel of course system can be found at left upper corner of main panel, and can be switched on by **Shift-i** keys pressing; prior usage, needed mode of system got to be set, and other systems of plane got to be shifted in according positions. Each of these modes is described at relevant chapter.

By default, system is used at directional mode.

To switch it into automatic mode, turn «РЕЖ. УПР.» switch by **i** key pressing.

At automatic mode, emergency system stop could be used by stick or throttle handles.

Automated takeoff

Simulator puts model at beginning of runway by default, that allows takeoff without initial taxi, which could be hard in comparison with other planes.

Turn antiskid braking automation by **Ctrl-b** keys pressing, stabilization automation by **Ctrl-s**, flaps blowing mode by **Ctrl-q**.

Turn on «Azure» command line by mouse.

Keep small «СБРОС» reset button at left bottom of «Azure» panel pressed for a second or two.

Switch command line to third code, and find wave and shift corresponding runway which model is at. Final number of "voice" message and number at runway got to be same, distance indicator at middle of main panel got to show zero, big needle of course indicator at left top of panel — to be directed in opposition to model axis, shown by thin one.

Turn on both Pitot tubes heating.

Attention! With prolonged delay at runway heaters could burn out. Without heaters Pitot tubes are freezing at subsonic flight at higher altitudes, and most of instrumentations starts to show wrong values, with all resulting aftermath. Switch on Pitot tubes heating just prior takeoff only.

Switch course system to «ВЗЛЁТ» mode. Mouse allows to shift center of view with right button of it pressed, and it's possible in one of its modes selected by **Tab** key also. Zoom is controlled by mouse wheel a that mode, and by **x/Shift-x** keys at others. If it's needed, zoom for exact control. Attention! Normal takeoff pitch angle, controlled by «ТАНГАЖ» switch is equal to 10 degrees, and it's more or less exact. At case of significant runway pitch angle, change switch position to prevent tail hit or rolling out.

Turn course system on. Engines will automatically change throttle to lower reheat, and flaps will be extracted to takeoff mode.

Switch parking brakes off by **Shift-b** keys pressing. Brakes handle at bottom of throttle levers got to direct froward.

Takeoff, leveling, gears and flaps retractions, are made automatically; on reaching altitudes higher that critical 500m system stops to control model, «РЕЖ 2» lamp switches off.

Turn system off, and start manual flight.

Manual takeoff

Manual takeoff is made without flaps blowing, but with stabilizing and brakes automations on, at lower reheat, with flaps extracted at middle position; flaps are controlled by **]/[** keys, throttle levers are controlled by **PgUp/PgDown**.

Rudder effectiveness is low at lower speeds, so at beginning of runway yaw is controlled by differential brakes, by pedals shift and brake lever at stick pressed by **b** key. If You do not have pedals, run simulator with --enable-auto-coordination parameter, with that pedals is coordinated with stick.

Attention! At beginning of run take stick a little, and keep it that way. At other case stabilization automation could press nose down, which, in sum with some roll, would lead to wild skids at forward wheel and one of side wheels, with weak contact of other, what can not be parried by brakes or rudder.

Make estrangement from runway by two stages approach. At first, wait model to get 8..10deg pitch angle, then put stick at middle position. After first wheel estrangement keeping yaw at axle of runway is possible by rudder only, avoiding nose peck. Wait main wheels estrangement, then get stick a bit more to keep constant speed.

Attention! Stabilization automation at --enable-auto-coordination mode sums attempts to roll model at runway, and could try to roll it wildly, which could demand immediate parring reaction.

In case of regular problems with it, keep **l** key pressed at takeoff, that turns on leveling mode of course system, even with main course system switch off. Course system automatically keeps roll angle at 0, and pitch angle at value set by «ТАНГАЖ» switch.

Attention! If pitch angle of runway not equals zero, 10deg set by define could lead to tail hit or rolling out at that mode also. Set it to correct angle prior, summing 10deg and runway pitch angle.

After takeoff, switch reheat off by keeping **PgDown** immediately, retract gears by **g** key pressing until green lamps of full retraction indictation, and retract flaps by **[** key. Extracted gears stuck at 500 km/h, and could be teared apart at ~600. Flaps can endure a bit higher speeds, but tears at maneuvering.

After gears and flaps retracted, start manual flight.

Manual flight

Model is simple and easy at common flight, but has some critical modes, at which it could went to malfunction, and since chain reaction of malfunctions is possible at model, to critical situation.

Speeding over critical Mach number defined by altitude would lead to engines overheating and could cause fire. Up to 10km higher speeds is around 1.5Mach, higher — 2.Mach. On «ВЫКЛЮЧИ ФОРСАЖ», «СБРОСЬ ОБОРОТЫ» lamps ignition immediately switch heating off and lower throttle by **PgDown** key until lamps switch off.

Stabilization automation keeps g-forces lower than 4g, but with fast braking to subsonic effectiveness of control surfaces grows rapidly, as turn radius rapidly decreasing, and parring reaction speed of automate could become lower than g-force growing speed. At fast g-force growing put stick at middle by **5** key pressing immediately. Destruction g-force of model is comparatively low for fighters, and equals 6g.

Model has speedbrakes, which are controlled by **j/k** keys, and these are quite effective at oversonic flight. But speed of intakes resurfacing is low comparatively, and on fast braking from 2Mach amount of income air could become lower than needed, that could lead to surging and engines cutoff. Keep Mach number around 1.6 until full intakes resurfacing to normal low-speeds position around 8x10.

Side intakes could be aerodynamically shaded by fuselage, that could lead to cutoff too. Avoid fast yaw turns at oversonic flight.

Also, theoretically, one or both engines could switch off at altitudes higher than 25km due to needed amount of intake air absence. At practice, speed decreasing to stall limit faster.

Attention! At higher altitudes engine cutoff immediately shift second one throttle to maximum reheat, put nose down, start descending and use midair starting procedure. At lower altitudes model is unstable at instrumentations speeds lower than ~300..400km/h, and these grows to 400...500km/h at higher ones, without thrust it starts to spin even more easily. Aerodynamic configuration of plane, heavy one with small wings, means that spin is dead-end case on it, so avoid it.

Following to beacon at manual flight

Open simulator menu by **F10** key, open map by menu, or by **Ctrl-j** keys pressing. Turn Navaids and Data, on, find needed NDB beacon, and remember its frequency.

Switch to radiocompass panel view mode by repeated **Shift-v** keys pressing. Switch panel to «АНТ» mode and set it to needed frequency by «ДИАПАЗОН», «НАСТРОЙКА ГРУБАЯ», «НАСТР. ПЛАВН» knobs. If beacon is in range then correct set is accorded by sound signal.
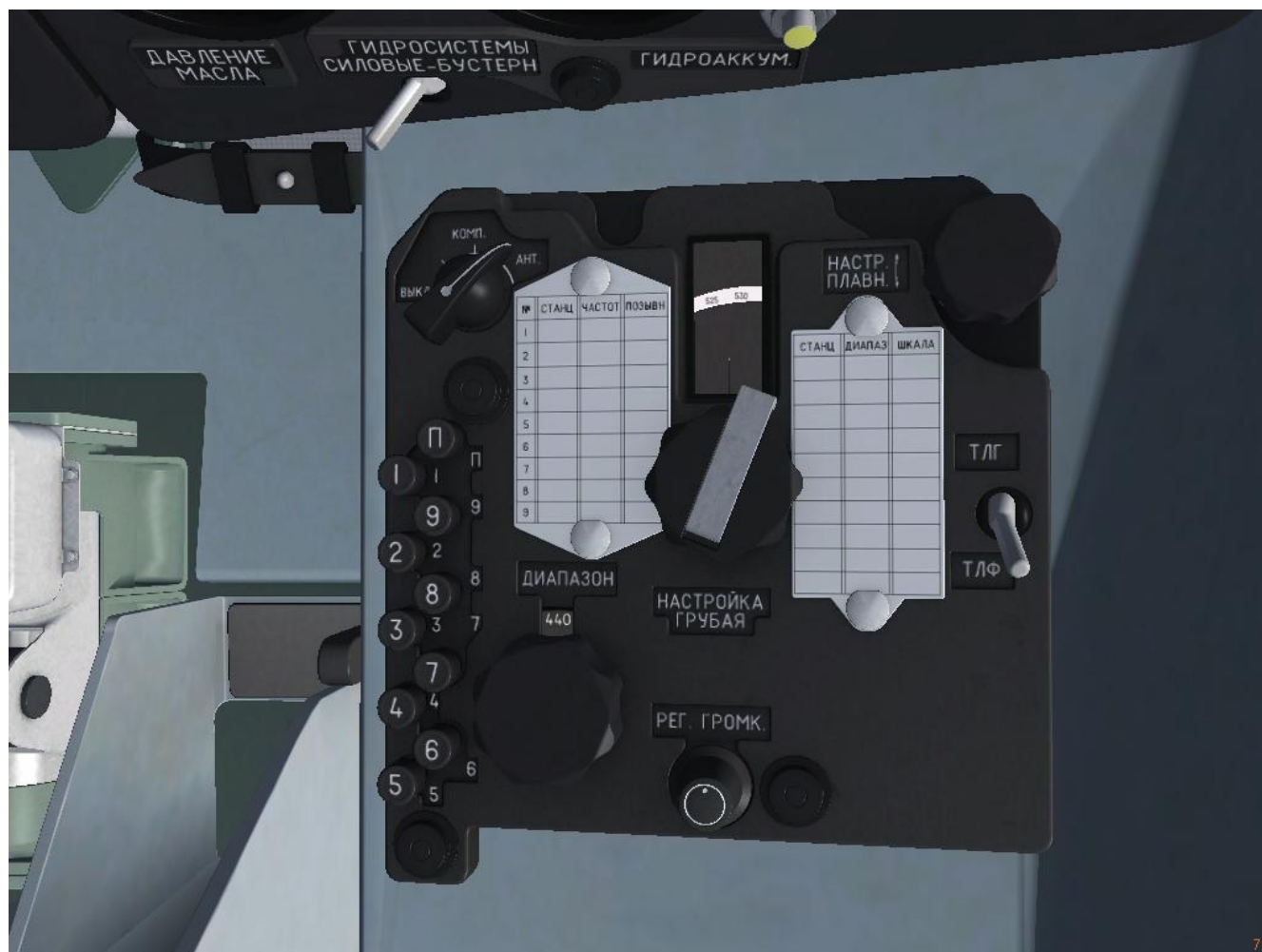
Switch panel to «КОМП» mode.
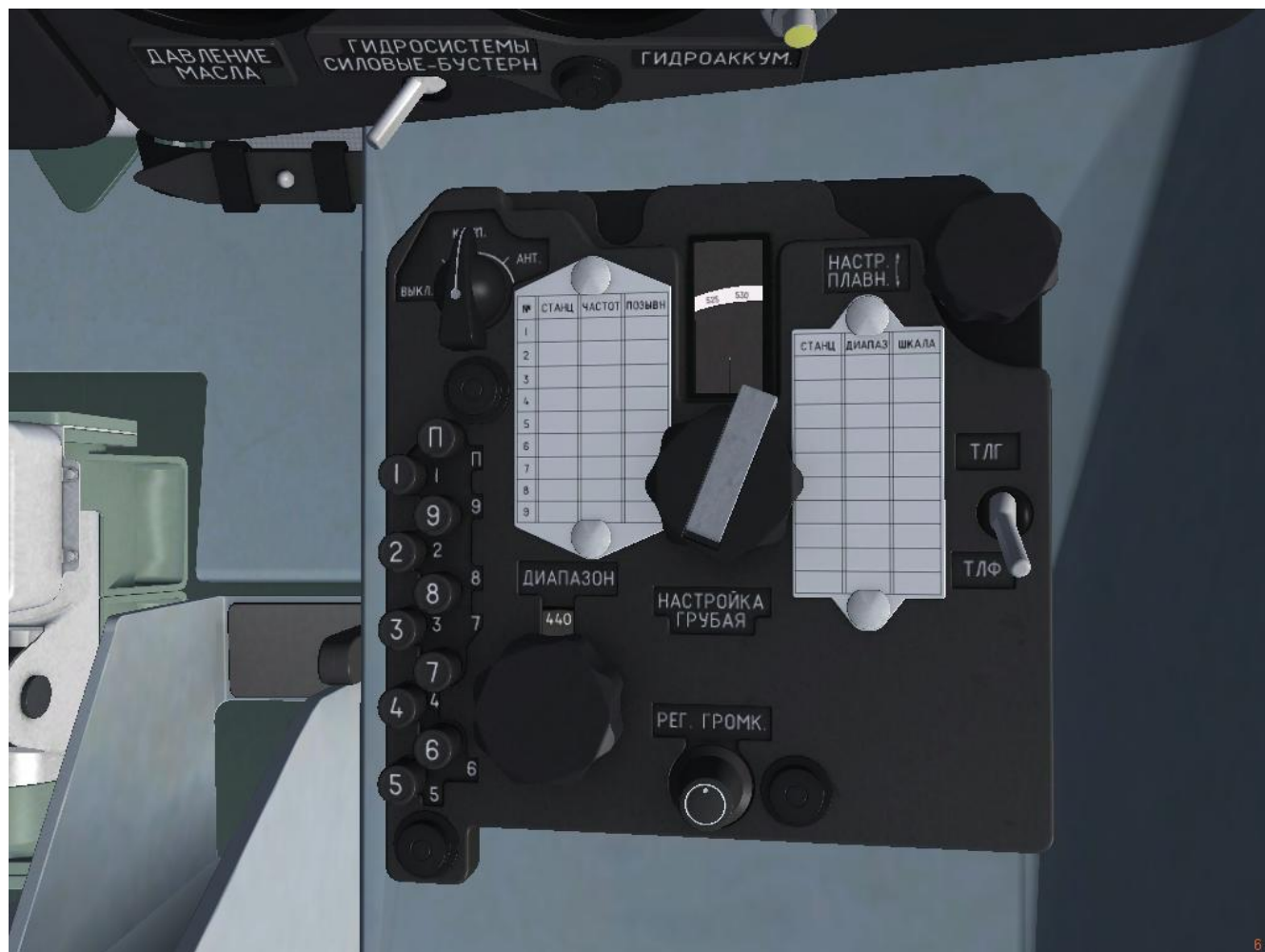
Set switch at main panel to «АГД-II» mode. Distance indicator got to show distance to beacon in kilometers, while course indicator — course to beacon, at «РП» mode shown by indication circle. Also, following to selected runway of «Azure» command line is possible at «АГД-I» mode, then indicator is in «КУРС» mode.

Automated following to beacon

Switch course system panel to «СЛЕД» mode, put stick at middle position, check that stabilization automate is on and course indicator shows direction to beacon or airport. Switch course system on. System leads machine to beacon at altitude set by «УПР Н» switch, speed is controlled automatically; at altitudes up to 10km automate sets speed at 0.8Mach, at higher altitudes — at higher speeds, up to 2Mach inclusive. Take in mind that fuel consumption at reheat is quite greater than at common regime of engines usage — without reheat model can fly three hours at distances up to 3000km, BTW, at speeds near 1.5Mach, at reheated oversonic flight duration time is half of hour maximum, and distance is around 1000km.

To avoid error turns which are possible on closing to beacon with distances less than 10km, also on beacon signal absence, system switches to second mode, keeping horizontal flight at set altitude, ant it it stays on that even at distance growing. To return to first mode, switch system off and on again.

Automated leveling

Automated leveling is occurred on **l** key pressing, and has three modes, depending on «ТАНГАЖ» switch position. At common mode, from ~0 to ~15 degrees, system leveling machine to 0 at roll angle, and to pitch angle that set by switch.

Attention! Leveling at that mode is made by angles of artificial horizon. If that is not corrected than leveling could lead to some mistakes.

At extreme left position of switch, «ГОРИЗОНТ», it sets to 0 both roll angle and vertical speed, shown by thin needle of vertical speedometer/roll indicator combined instrument.

At extreme right position, «ГОРКА», system leads machine to 10km shell, speeds it up at reheat to 2Mach, then climbs at 30deg to indicated air speed decreasing lower than 500km/h, which corresponds altitudes around 22..23km, then leads it back to shell. If **l** key is pressed still then whole procedure goes on again.

Automated landing

Press button «СЛИВ ТОПЛ.» at main panel and keep it to finishing of fast fuelometer needles moving.

Without fuel dumping out of frontal and wings tanks, maximal elevator moment is not enough to parry moment of extracted flaps at landing speeds. Landing without fuel dumping could be performed manually only, at greater angles of attack means faster leveling prior touchdown. With fuel exhausting of frontal tank, landing can be performed with flaps extracted to middle takeoff position with blowing mode on. Without it landing can be performed without flaps extraction only.

Verify dumping by control lamps at right panel. Lamps of frontal and wings tanks got to be turned off.

On need, move seat higher by **Shift-d** keys for better view at greater angles of attack.

Open map and find needed runway. Length of runway is got to be around 2km, pitch angle of runway better to be 0, otherwise set «ТАНГАЖ» switch to 10deg plus pitch angle of runway. Approaching got to be even enough, and for sure altitude of runway got to be same at terrain and map of simulator, etc . For example approaching from seaside at Sochi, runway 06, leads to correct landing, while from mountains, 24 — is not.

Switch command line on, and find wave and shift of needed runway at third code. With far flight, «СБРОС» key got to be pressed prior search. Check that both stabilizing and wheels braking automations is on, switch braking chute preventer off by **Ctrl-t** keys pressing.

Check that stick is in neutral position, switch course system to «ПОС» mode.

Switch course system on. At 10km echelon, distance to runway got to be 50km at least. At oversonic high altitude flight — greater than 100km. At first, automate leads machine to turn point at 20km ahead of runway, and it could deny if that point is inside of minimum turn circle at current speed .

On turn point reaching, system switches to «РЕЖ 2» mode, makes turn to runway, controlling both speed and altitude, and performs glissade descent. At speed of 600km/h flaps are extracted automatically, at speed of 450km/h — gears are extracted.

On runway touching, automate extract braking chute, leads machine to axle of runway by differential brakes, and braking until full stop.

Attention! Switch off Pitot tubes heaters immediately after stop. Otherwise it could burn out, that would lead to instrumentation fail on later flight.

Manual landing

Set command line to landing runway. Lead machine to point of 20km distance from it, and altitude excess of 2km above, with speed of 800km/h. On point reaching, decrease throttle to minimum by **PgDown** key, and start turn to it. At need, use speedbrakes controlled by **j/k** keys.

At speeds less than 600km/h extract flaps fully by **]** key twice pressing. Check that flaps blowing mode is on, and throttle handles is above blowing mode protectors — spins got to be greater than 75/50.

Switch braking chute preventer off by **Ctrl-t** keys pressing.

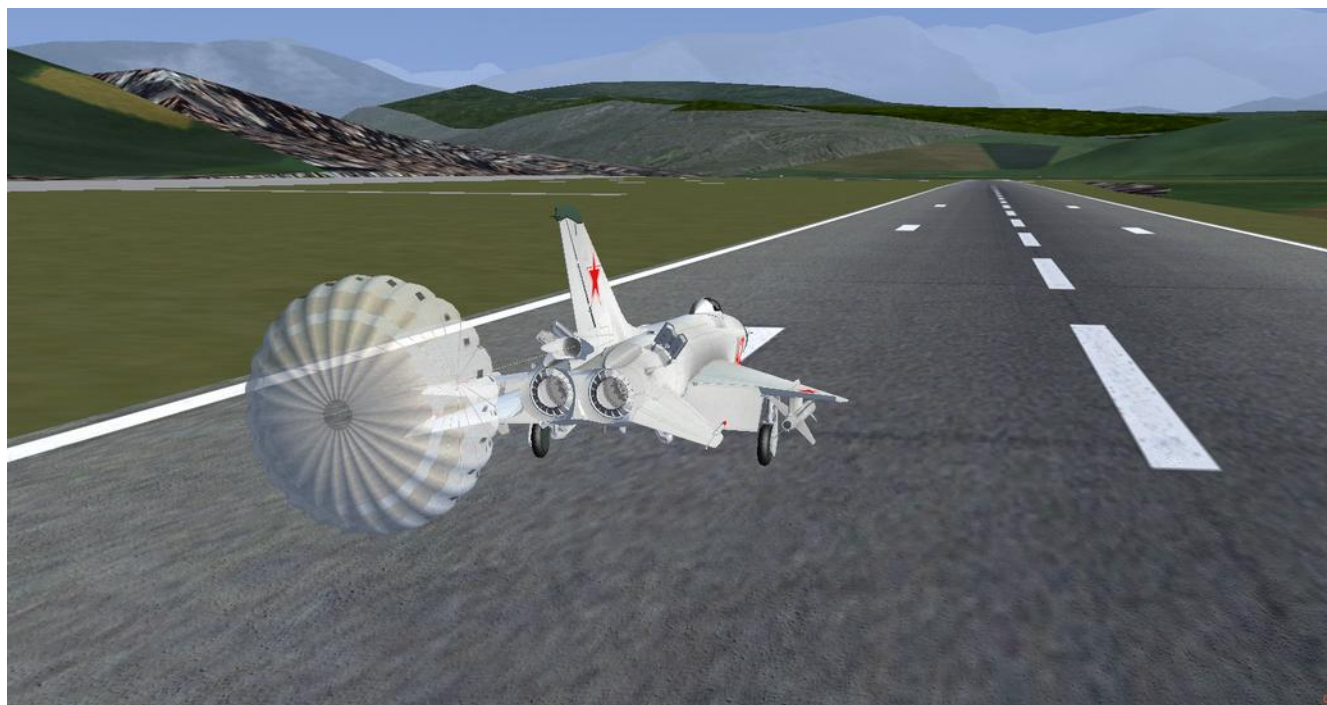At speed less than 500km/h extract gears by **Shift-g** keys.

Speed got to be in 300..400km/h interval, vertical speed got to be less than 10m/sec.

At touch speed got to be 325..350km/h, vertical speed — 1..2.5m/sec.

After touch extract braking chute by **c** key pressing immediately.

Keep machine at runway axle by differential brakes, keep **b** key pressed until full stop. Chute is dropped automatically.

Attention! Do not put nose down by stick. Stabilization automate sums such attempts and that could lead to skid on front gear and one of main gears, with weak contact of other one. Such skid can not be parried by rudder or brakes.

After full stop start taxi to parking position.

Attention! Switch off Pitot tubes heaters immediately after stop. Otherwise it could burn out, that would lead to instrumentation fail on later flight.

Automated convoy

Select needed target at «Azure» panel at first code. On need, press and keep «СБРОС» button.
Targeting is possible at case both target and machine flight altitudes it higher than 500m.

Prepare course system panel by «СОПР» mode selection, set «ТАНГАЖ» and «УПР X» switches. Switch «УПР X» sets convoy distance to target, from 100m to 5km, median position is around 2km. Switch «ТАНГАЖ» sets pitch angle to target at convoying distance.

Switch course system on. At case of counter approach it swotches to first mode and leads machine to turn point aside of target path, at other case — to second one and point back of target tail.

Machine follows target automatically. Manual convoy is made same manner, but without course system.

Automated interception

Switch «Azure» on, keep «СБРОС» pressed for a while, select target by wave and shift selection at first code. Prepare armament by «ПОДГОТ» and «НАВЕД» switches.

Prepare course system by switching to «ПЕР» mode, and set target excess altitude angle by «ТАНГАЖ» switch, it should be around 5deg.

Check that stick is in neutral position, and switch course system on.

At distance to target around 30km switch radar to target selection mode by **Shift-l** keys pressing.

At distances around 20km switch automation to radar following mode by **Ctrl-l** keys pressing.
Machine automatically turns to keep target in middle of radar cross.

At distances around 10km missiles selects target, which is shown by «H» indication lamps ignition. At tail approach target is visible by both missiles, at counter approach — only by right one, with halfactive radar system. At other hand, infrared missile can see target with earth surface behind it, while halfactive one could not do so.

At distance around 5km fire missiles by **f** key holding.

Missiles signal loss is indicated by «З» lamps, catch of missiles rangefinders — by «ПП» lamps.

At distances less than 1km to target, which are indicated by «0» lamp, course system switches to «РЕЖ 2» mode, and makes turn off from target at direction set by «ПЕРЕСТР» switch, then leveling machine to horizontal flight, then switches off.

Manual interception is made same way without course system. Radar got to be switched at target selection mode, at other case Р-8Р missile with halfactive guidance head seeing it at «ФИ-0» close search mode only. Radar following mode can be switched on at manual flight too, but fully manual interception is possible also.

At all modes of course system, leveling ones exclusive, emergency offswitch is possible by stick or throttle handles manual shifting.

Midair engines start

Midair engine cutoff commonly indicated by first turbine spin exceeding spin of second one, plus normal engine working sound absence.

Turn emergency electrical scheme on, switch some load off, manually as shown at screen, or by **e** key. Check that all relays at relays panel, which positioned left bottom of main one, is on.

Turn airstart engines mode by **Shift-s** keys, check that flaps blowing mode is off, and shift throttle handles down at low throttle protectors by **PgDown** key.

Put machine at slow descend with constant speed faster than 500km/h, wait engines to spin to normal 30/60 mode.

Switch airstart mode off, shift throttle handles to normal flight position.

Turn all load on by common red handle.

Continue flight. At need correct gyrocompass and artificial horizon by pressing and holding buttons at indication gauges via mouse.

Actions at engine fire

Engine fire is indicated by «ПОЖАР» lamp.

Switch emergency sound signal off by **w** key. Look at right panel and switch emergency electrical scheme on by **e** key.

Check which engine is burning by two switches at engines start panel at right bottom. If right engine is burning then lamp aside of two switches lights on right one pressing.

Cut off fuel of burning engine at right panel, «ЛЕВ» is left one, «ПРАВ» is right, then switch on extinguisher by red button at left of it pressing and holding, until extinguishing sound and lamp «ПОЖАР» at main panel is off.

Continue flight with one engine.

Landing with one engine is possible at case of good visibility and good initial altitude. It made by radiocompass, with flaps extracted at full, without flaps blowing, at reserving hydraulic pump extracted by **Ctrl-p** keys, and with braking chute. It's recommended to rise seat prior it – pitch angles could be comparatively high.

Vertical speed at landing got to be less than 10m/sec, pitch angle — not more than 10deg, avoiding tail hit. Median horizontal speed at emergency landing is around 450km/h. Emergency extraction of flaps and gears is possible by pneumatic system, made by «ЗАКРЫЛКИ» and «ШАССИ» handles.

Probability of landing at one engine with some flight experience is high, but no second attempt is possible with it – at lower speeds plane starts to roll, as half of control surfaces is not enough to parry moments, while speedup at one engine is quite low. At both engines fire — «leave plane» by restarting of simulator. Chances of landing without thrust is near to zero.
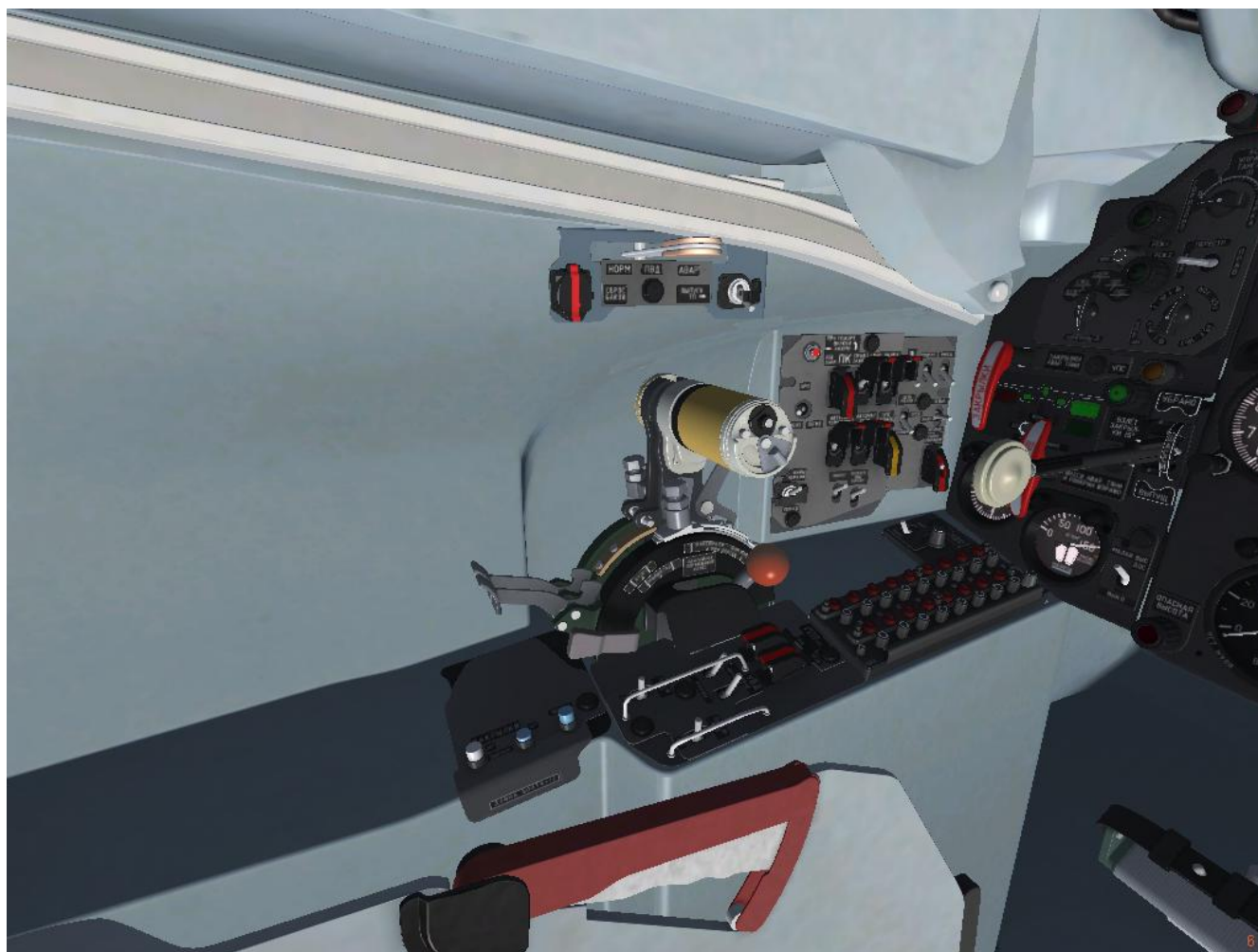
Taxi

Taxi is made with control surfaces retracted, both automations switched off, and without flaps blowing mode. Turns are made by pedals shift with stick braking handle pressing by **b** key.

On need, external lamps can be extracted by switch at left bottom of left panel; lamps retracting could be made by switch, or these retracts automatically at speeds higher than 400km/h.

Keyboard shortcuts

Shift-`	Throttle keys controls both engines
Shift-1	Throttle keys controls left engine
Shift-2	Throttle keys controls right engine
PgUp	Throttle increasing
PgDown	Throttle decreasing
s	Engines start
r	Throttle handles blocker
Shift-r	Low throttle and flaps blowing mode protectors
Shift-s	Midair engines start mode
Ctrl-[	Intakes control mode, manual/automatic
Shift-[	Intakes panels retracting
Shift-]	Intakes panels extracting
j	Speedbrakes retracting
k	Speedbrakes extracting
l	Automatic leveling mode
Shift-l	Radar target selection mode
Ctrl-l	Radar target following mode
n	Seat stripes protract/expand
Ctrl-b	Braking automation
Ctrl-t	Braking chute protector
b	Brakes
Shift-b	Parking brake
c	Braking chute extraction
Ctrl-s	Stabilization automate
Ctrl-d	External tanks drop
Ctrl-p	Emergency hydraulic pump
Shift-c	Canopy close/open
Ctrl-f	Fuelometer mode standard/wings and external tanks
w	Warning signal stop
Ctrl-q	Flaps blowing mode
q	Check of flaps blowing mode
m	Stick mode, easy/hard
f	Missiles fire
e	Emergency electrical scheme
Shift-e	Starting electrical scheme
Ctrl-e	Main electrical scheme
g	Retract gears

Shift-g	Extract gears
d	Lowering seat cup down
Shift-d	Rising seat cup up
Shift-i	Course system on/off
i	Course system director/automatic modes switch